WE CLAIM:

1. An electrical current generating system comprising:

a fuel cell including an anode channel including an anode gas inlet for receiving a supply of hydrogen gas, a cathode channel including a cathode gas inlet and a cathode gas outlet, and an electrolyte in communication with the anode and cathode channel for facilitating ion exchange between the anode and cathode channel;

an oxygen gas delivery system coupled to the cathode gas inlet for delivering a gaseous stream enriched in oxygen gas to the cathode channel, the oxygen gas delivery system including a rotary pressure swing adsorption system for enriching oxygen in a gaseous feed.

2. The system according to claim 1 and further comprising a first gas recirculation means coupled to the cathode gas outlet for recirculating a first portion of cathode exhaust gas exhausted from the cathode channel to the cathode gas inlet.

3. The current generating system according to claim 1 where the pressure swing adsorption system includes a first feed gas inlet for receiving air feed as a first gas feed, and a gas outlet coupled to the cathode gas inlet.

4. The current generating system according to claim 3 where the oxygen gas delivery system includes a gas inlet for receiving a first portion of cathode gas exhausted from the cathode channel and a gas outlet for delivering the gaseous stream enrich in oxygen gas to the cathode channel.

5. The current generating system according to claim 4 where the oxygen gas delivery system includes a first gas recirculation means coupled to the cathode gas outlet for recirculating the first portion of cathode gas from the cathode channel to the cathode gas inlet.

6. The current generating system according to claim 5, wherein the first gas recirculating means comprises a compressor for supplying the first cathode exhaust gas portion under pressure to the cathode gas inlet.

7. The current generating system according to claim 6, wherein the first gas recirculation means includes a condensate separator coupled between the cathode gas outlet and the compressor for removing moisture from the first cathode exhaust gas portion.

8. The current generating system according to claim 6, wherein the FIRST gas recirculating means directs the first cathode exhaust gas portion as feed gas to the gas separation system.

9. The current generating system according to claim 4, wherein the gas separation system includes a second feed gas inlet, and the current generating system includes second gas recirculating means coupled to the cathode gas outlet for recirculating a second portion of the cathode exhaust gas to the second feed gas inlet.

10. The current generating system according to claim 9 wherein the recirculating means comprises a restrictive orifice for delivering the second cathode exhaust gas portion to the gas separation system at a pressure less than a pressure of the air feed.

11. The current generating system according to claim 9 where the pressure swing adsorption system comprises a rotary module including a stator and a rotor rotatable relative to the stator, the rotor including a plurality of flow paths for receiving adsorbent material therein for preferentially adsorbing a first gas component in response to increasing pressure in the flow paths relative to a second gas component, and compression machinery coupled to the rotary module for facilitating gas flow through the flow paths for separating the first gas component from the second gas component.

12. The current generating system according to claim 11 wherein the plurality of flow paths are aligned with the axis of the rotor.

13. The current generating system according to claim 11, wherein the stator includes a first stator valve surface, a second stator valve surface, a plurality of first function compartments opening into the first stator valve surface, and a plurality of second function

compartments opening into the second stator valve surface, and the rotor includes a first rotor valve surface in communication with the second stator valve surface, and a plurality of apertures provided in the rotor valve surfaces and in communication with respective ends of the flow paths and the function compartments.

14. The current generating system according to claim 13 where the compression machinery is coupled to a portion of the function compartments for maintaining the portion of function compartments at a plurality of discrete respective pressure levels between an upper pressure and a lower pressure for maintaining uniform gas flow through the portion of function compartments.

15. The current generating system according to claim 13, wherein the function compartments include a light reflux exit compartment and a light reflux return compartment, the compression machinery comprises a light reflux expander coupled between the light reflux exit and return compartments, and the first gas recirculation means comprises a compressor coupled to the light reflux expander for supplying the first cathode exhaust gas portion under pressure to the cathode gas inlet

16. The current generating system according to claim 15 wherein the rotary pressure swing adsorption system includes a heater disposed between the light reflux exit compartment and the light reflux expander for enhancing recovery of energy from light reflux gas exhausted from the light reflux exit compartment.

17. The current generating system according to claim 15 where the function compartments include a gas feed compartment and a countercurrent blowdown compartment, and the compression machinery comprises a compressor coupled to the first feed gas inlet for delivering compressed air to the gas feed compartment, and an expander coupled to the compressor for exhausting heavy product gas enriched in the first gas component from the countercurrent blowdown compartment.

18. The current generating system according to claim 15 where the function compartments include a countercurrent blowdown compartment and a heavy product compartment, and the compression machinery comprises an expander coupled to the countercurrent blowdown compartment.

19. The current generating system according to claim 18 further comprising a vacuum pump coupled to the expander for extracting heavy product gas enriched in the first gas component at subatmospheric pressure from the heavy product compartment.

20. The current generating system according to claim 13 where the function compartments include a gas feed compartment, and the gas recirculating means directs the first cathode exhaust gas portion as feed gas to the gas feed compartment.

21. The current generating system according to claim 13 where the function compartments include a gas feed compartment, and the current generating system includes second gas recirculating means coupled to the cathode gas outlet for recirculating a second portion of the cathode exhaust gas to the gas feed compartment.

22. The current generating system according to claim 21 where the second gas recirculating means comprises a restrictor orifice.

23. The current generating system according to claim 11 where the adsorbent material is one of CA-X, Li-X, lithium chabazite zeolite, calcium-exchanged chabazite and strontium-exchanged chabazite.

24. The current generation system according to claim 1 where the rotary pressure swing adsorption system enriches oxygen and removes carbon dioxide from an air feed.

25. The current generation system according to claim 24 further comprising a hydrogen gas delivery system coupled to the anode gas inlet.

26. The current generation system according to claim 25 where the hydrogen gas delivery system enriches hydrogen gas in a gaseous feed.

27. The current generation system according to claim 26 further comprising an oxygen accumulator interposed between the oxygen gas delivery system and the cathode gas inlet

28. The current generation system according to claim 27 in which the electrolyte is alkaline and is maintained at a working temperature greater that about 100°C, the oxygen gas delivery system is operated to supply oxygen of about 90% purity to the cathode gas inlet, so that the product water of the fuel cell is delivered as concentrated dry steam from the cathode gas outlet; the system including a steam expander to expand the steam from the cathode gas outlet to a vacuum condenser, a condensate pump to exhaust liquid from the condenser, and a vacuum pump cooperating with the oxygen pressure swing adsorption system and exhausting permanent gas overheads from the vacuum condenser.

29. Electrical current generated by the electrical current generating system according to claim 1.

30. The current generating system according to claim 8 where the rotary pressure swing adsorption system comprises a rotary module for implementing a pressure swing adsorption process having an operating pressure cycling between an upper pressure and a lower pressure, for extracting a first gas fraction and a second gas fraction from a gas mixture including the first and second fractions, the rotary module comprising:

a stator including a first stator valve surface, a second stator valve surface a plurality of first function compartments opening into the first stator valve surface, and a plurality of second function compartments opening into the second stator valve surface; and

a rotor rotatably coupled to the stator and including a first rotor valve surface in communication with the first stator valve surface, a second rotor valve surface in communication with the second stator valve surface, a plurality of flow paths for receiving adsorbent material therein, each said flow path including a pair of opposite ends, and a plurality

of apertures provided in the rotor valve surfaces and in communication with the flow path ends and the functions ports for cyclically exposing each said flow path to a plurality of discrete pressure levels between the upper and lower pressure for maintaining uniform gas floe through the first and second function compartments, the function compartments comprising first and second gas geed compartments opening into the firs stator valve surface for delivering the gas mixture to the flow paths for sequentially exposing the flow paths to the second feed gas prior to the firs feed gas.

31. The current generation system according to claim 30 where the second feed gas is enriched in oxygen relative to the first feed gas.

32. An electrical current generating system comprising:

a fuel cell including an anode channel including an anode gas inlet and an anode gas outlet, a cathode channel including a cathode gas inlet and a cathode gas outlet, and an electrolyte in communication with the anode and cathode channel for facilitating exchange between the anode and cathode channel;

an oxygen gas delivery system coupled to the cathode gas inlet for delivering oxygen gas to the cathode channel; and

a hydrogen gas delivery system coupled to the anode gas inlet for delivering a gaseous stream enriched in hydrogen gas to the anode channel, including a first rotary pressure swing adsorption system for enriching hydrogen in a gaseous feed

33. The electrical current generation system according to claim 32 where the first rotary pressure sing adsorption system includes a first gas feed gas inlet for receiving a first gas feed comprising hydrogen gas and a gas outlet coupled to the anode gas inlet.

34. The electrical current generation system according to claim 33 where the hydrogen gas delivery system includes a gas inlet for receiving a second gas feed from the anode gas outlet and a gas outlet for delivering the gaseous stream enriched in hydrogen gas to the anode channel.

35. The electrical current generation system according to claim 34 where the second gas feed is passed through the first rotary pressure swing adsorption system.

36. The electrical current generation system according to claim 35 where the first rotary pressure swing adsorption system includes a second feed gas inlet for receiving the second gas feed.

37. The electrical current generating system according to claim 32 where the oxygen gas delivery system comprises an oxygen gas separation system for extracting oxygen gas from air, the gas separation system including a first feed gas inlet for receiving an air feed, and an oxygen gas outlet coupled to the cathode gas inlet for supplying enriched oxygen gas to the cathode channel from the air feed.

38. The electrical current generation system according to claim 36 where the oxygen gas delivery system comprises a second rotary pressure swing adsorption system for extracting oxygen gas from the air, the second rotary pressure swing adsorption system including a first feed gas inlet for receiving an air feed an a gas outlet coupled to the cathode gas inlet for supplying a gaseous stream enriched in oxygen gas to the cathode channel.

39. The electrical current generating system according to claim 36 where the hydrogen gas delivery system comprises a reactor for producing a second gas feed from hydrocarbon fuel, and wherein the first rotary pressure swing adsorption system is coupled to the reactor for receiving the first and second gas feeds.

40. The electrical current generating system according to claim 39 wherein the hydrogen gas delivery system comprises a reactor for producing a second hydrogen gas feed from hydrocarbon fuel, and wherein the first rotary pressure swing adsorption system is coupled to the reactor and receives the first and second gas feeds.

41. The electrical current generating system according to claim 40 where the first rotary pressure swing adsorption system receives the first and second gas feeds, and produces a gaseous stream enriched in hydrogen therefrom.

42. The electrical current generating system according to claim 41 where the first rotary pressure swing adsorption system hydrogen includes a first feed gas inlet for receiving the first gas feed, and a second feed gas inlet for receiving the second gas feed.

43. The electrical current generating system according to claim 42 where the first gas feed is provided at a pressure level different from a pressure level of the second gas feed.

44. The electrical current generating system according to claim 43 where the reactor comprises a steam reformer, and a water gas shift reactor coupled to the steam reformer for producing the second gas feed.

45. The electrical current generating system according to claim 44 where the steam reformer includes a burner including a first burner inlet coupled to the cathode gas outlet for receiving humid oxygen-enriched gas, and a second burner inlet for receiving heavy product from the first rotary pressure swing adsorption system for burning within the burner for providing endothermic heat of reaction for steam reforming the hydrocarbon fuel.

46. The electrical current generating system according to claim 39 wherein the reactor comprises an autothermal reformer, and a water gas shift reactor coupled to the steam reformer for producing the second gas feed.

47. The electrical current generating system according to claim 46 where the oxygen gas delivery system comprises a second rotary pressure swing adsorption system for extracting oxygen gas from air, the second rotary pressure swing adsorption system including a first feed gas inlet for receiving an air feed, and a gas outlet coupled to the cathode gas inlet for supplying a gaseous stream enriched in oxygen gas to the cathode channel, and the reactor comprises a burner including a first burner inlet for receiving air, and a second burner inlet for

receiving a gaseous stream enriched in hydrogen gas from the first rotary pressure swing adsorption system for burning the received hydrogen gas within the burner for recovery of heat energy for pressurizing the air feed.

48. The electrical current generating system according to claim 47 where at least one of the pressure swing adsorption systems comprises a rotary module including a stator and a rotor rotatable relative to the stator, the rotor including a plurality of flow paths for receiving adsorbent material therein for preferentially adsorbing a first gas component in response to increasing pressure in the flow paths relative to a second gas component, and compression machinery coupled to the rotary module for facilitating gas flow through the flow paths for separating the first gas component from the second gas component.

49. The current generating system according to claim 48 where the stator includes a first stator valve surface, a second stator valve surface, a plurality of first function compartments opening into the first stator valve surface, and the rotor includes a first rotor valve surface in communication with the first stator valve surface, a second rotor valve surface in communication with the second stator valve surface, and a plurality of apertures provided in the rotor valve surfaces and in communication with respective ends of the flow paths and the function compartments.

50. The current generating system according to claim 49 wherein the compression machinery is coupled to a portion of the function compartments for maintaining the portion of function compartments at a plurality of discrete respective pressure levels between an upper pressure and a lower pressure for maintaining uniform gas flow through the portion of function compartments.

51. The electrical generating system according to claim 33 further comprising a gas recirculation means coupled to the cathode gas outlet for recirculating a portion of cathode exhaust gas exhausted from the cathode channel to the cathode gas inlet.

52. The electrical generating system according to claim 39 further comprising a gas recirculation means coupled to the cathode gas outlet for recirculating a portion of cathode exhaust gas exhausted from the cathode channel to the reactor for producing hydrogen from hydrocarbon fuel.

53. Electrical current generated by the electrical current generating system of claim 33.

54. A method of generating an electric potential, comprising:

providing a fuel cell including an anode channel including an anode gas inlet, a cathode channel including a cathode gas inlet and a cathode gas outlet, and an electrolyte in communication with the anode and cathode channel for facilitating ion exchange between the anode and cathode channel;

supplying a gaseous stream enriched in oxygen gas to the cathode gas inlet, where the supplying step comprises supplying a first gas feed to a rotary pressure swing adsorption apparatus to produce a product gas stream enriched in oxygen gas; and

delivering the product gas stream to the cathode gas inlet.

55. The method according to claim 54 and further comprising recirculating a portion of cathode gas exhausted from the cathode gas outlet to the cathode gas inlet.

56. The method according to claim 55 where recirculating comprises delivering the exhaust gas portion to the rotary pressure swing adsorption apparatus as a second gas geed.

57. The method according to claim 56 where the recirculating further comprises purging a remainder of the exhausted cathode gas.

58. The method according to claim 57 where recirculating comprises delivering the exhaust gas portion at increased pressure to the cathode gas inlet.

59. The method according to claim 58 where recirculating further comprises recovering waste heat from the fuel cell for enhancing recovery of expansion energy from the pressure swing adsorption apparatus.

60. The method according to claim 54 where supplying hydrogen gas comprises recirculating a portion of cathode gas exhausted from the cathode gas outlet to the inlet of a fuel processor for reacting a hydrocarbon fuel to generate hydrogen.

61. A method for generating electrical potential, comprising:

providing a fuel cell including an anode channel including an anode gas inlet, a cathode channel including a cathode gas inlet and a cathode gas outlet, and an electrolyte in communication with the anode and cathode channel for facilitating ion exchange between the anode and cathode channel;

supplying a first gaseous stream enriched in hydrogen gas to the anode gas inlet, where supplying comprises supplying a first gas feed to a rotary hydrogen pressure swing adsorption apparatus to produce a first product gas stream enriched in hydrogen gas;

delivering the first product gas stream to the anode gas inlet; and

supplying a second gaseous stream enriched in oxygen gas to the cathode gas inlet.

62. The method according to claim 61 and further comprising recirculating a portion of anode gas exhausted from the anode gas outlet to the anode gas inlet.

63. The method according to claim 62 where recirculating comprises delivering the exhaust gas portion to the rotary hydrogen pressure swing adsorption apparatus as a second gas feed.

64. The method according to claim 63 where supplying a second gaseous stream comprises supplying an air feed to a rotary oxygen pressure swing adsorption apparatus to produce a second product gas stream enriched in oxygen gas, and delivering the second product gas stream to the cathode gas inlet.

65. The method according to claim 64where supplying hydrogen gas comprises supplying a hydrocarbon fuel to a reformer, reacting the fuel with oxygen-enriched gas from the cathode gas outlet, delivering a hydrogen gas feed from the reformer as a first gas feed to a hydrogen pressure swing adsorption apparatus, and delivering hydrogen-enriched gas extracted from the first gas feed as light product gas to the anode gas inlet.

66. The method according to claim 65 where the reformer comprises a steam reformer including a combustor, and reacting comprises delivering the fuel to the combustor, and providing heat energy to the combustor by burning tail gas extracted from the rotary hydrogen pressure swing adsorption apparatus as heavy product gas with the oxygen-enriched gas from the cathode gas outlet in the combustor.

67. The method according to claim 65 where the reformer comprises a steam reformer including a combustor, and reacting comprises delivering the fuel to the combustor, and providing heat energy to the combustor by burning tail gas extracted from the rotary hydrogen pressure swing adsorption apparatus as heavy product gas with a portion of the air feed in the combustor, and recovering heat of combustion from the combustor for delivering air under pressure to the rotary oxygen pressure swing adsorption apparatus.

68. The method according to claim 65 where the reformer comprises an autothermal reformer including a water gas shift reactor, and the step of supplying a pressurized air feed comprises the steps of delivering air to a combustor, burning tail gas extracted from the hydrogen pressure swing adsorption apparatus as heavy product gas with the delivered air in the combustor, and recovering heat of combustion from the combustor for delivering air under pressure to the oxygen pressure swing adsorption apparatus.

69. An electrical current generating system comprising:

a fuel cell including an anode channel including an anode gas inlet and an anode gas outlet, a cathode channel including a cathode gas inlet and a cathode gas outlet, and an electrolyte in communication with the anode and cathode channel for facilitating ion exchange between the anode and cathode channel;

an oxygen gas delivery system coupled to the cathode gas inlet for delivering enriched oxygen gas to the cathode channel, the oxygen gas delivery system including a pressure swing adsorption system to enrich oxygen and to remove carbon dioxide from atmospheric air feed; and

a hydrogen gas delivery system coupled to the anode gas inlet for delivering purified hydrogen gas to the cathode channel.

70. The current generating system according to claim 69 further including an oxygen accumulator interposed between the oxygen gas delivery system and the cathode gas inlet. The method according to claim 65 where the reformer comprises a steam reformer including a combustor, and reacting comprises delivering the fuel to the combustor, and providing heat energy to the combustor by burning tail gas extracted from the hydrogen pressure swing adsorption apparatus as heavy product gas with the oxygen-enriched gas from the cathode gas outlet in the combustor.

71. The electrical current generation system according to claim 1 where the rotary pressure swing adsorption system comprises a plurality of adsorbers having first and second ends communicating respectively to a first valve face and a second valve face, the plurality of adsorbers being housed in an adsorber housing body cooperating with first and second valve bodies respectively sealingly engaged with the adsorber housing body at the first and second valve faces.

72. The electrical current generation system according to claim 71 where the adsorber housing body rotates relative to the first and second valve bodies.

73. The electrical current generation system according to claim 71 where the first and second valve bodies rotate relative to the adsorber housing.

74. The electrical current generation system according to claim 73 where the rotary pressure swing adsorption system further comprises transfer chambers providing fluid

communication between the first valve body and respectively a feed air inlet conduit and an exhaust discharge conduit.

75. The electrical current generation system according to claim 73 where the rotary pressure swing adsorption system further comprises a transfer chamber providing fluid communication between the second valve body and the product oxygen conduit to the cathode inlet.

76. The electrical current generation system according to claim 1 further where the pressure swing adsorption system generates a gaseous stream enriched in oxygen, the gaseous stream enriched in oxygen having a first oxygen purity and being fluidly coupled to the cathode gas inlet, the system further comprising a compressed air inlet for mixing compressed air with the gaseous stream enriched in oxygen upstream of the cathode gas inlet, thereby forming a cathode feed gas stream having a second oxygen purity lower than the first oxygen purity.

77. The electrical current generation system where the first oxygen purity is in the range of from about 70% to about 90% and the second oxygen purity is in the range of from about 30% to about 40%.